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PHYTOPATHOLOGICAL SURVEY OF SANTO DOMINGO.

By

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PHYTOPATHOLOGICAL SURVEY OF SANTO DOMINGO, 1925-1929

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INTRODUCTION

The scope of the present survey is limited to the most important diseases of plants of economic value which have so far been discovered in the Dominican Republic. Therefore we have prepared only a list of said diseases with remarks on the damage caused by the principal ones. Where no mention is made of the localities or geographical areas, it is understood that the disease is found practically in any place where the plant affected by the disease is grown, but in cases where the disease is restricted to a limited area, this fact is mentioned. The phytopathological survey of the Dominican Republic was started over four years ago and has been continued uninterruptedly to date. Our survey does not include diseases which affect plants recently introduced, or those grown for experimental purposes, or cultivated sporadically, neither does it deal with those which attack ornamental plants, except in a very few cases.

MYCOLOGICAL AND PHYTOPATHOLOGICAL SURVEYS

The first two phytopathological surveys in Santo Domingo, dealing only with sugar cane diseases were made by Johnston (14) and Stevenson (15) who in 1913 and 1917 identified almost all cane diseases and collected twenty-one different fungi on cane. In 1923 Faris published two papers; one on sugar cane diseases which was very complete (12) and the other on different cultivated plants (13), the latter being the first general phytopathological survey published to date. Although Faris, owing to his brief stay in Santo Domingo, was unable to identify all the principal diseases which affect the

cultivated plants he at least succeeded in classifying those of greatest economic importance. The author mentioned in the Annual Reports for the years 1925, 1926 and 1927 (3) of the Agronomy Station of Haina, later of Moca, some of the diseases discovered by him and in addition published a series of papers on the subject (4, 5, 6, 7), and also on the smuts of Santo Domingo. González Fragoso and the writer also published from 1925 to 1928, a series of sixteen mycological contributions (10) which comprised about five hundred species, among which there were some of economic importance. The fungi so far studied appeared in a general treatise or check list of the microflora of the Dominican Republic (9) published in 1928. Mention should also be made of four important contributions to mycology, one by Kern (16) deals with species of rusts some of which are of economic importance; another by Toro (17) is a study of several groups of fungi; and two papers by Carlos E. Chardon on American Dothideales (1, 2).

While mycological investigations in Santo Domingo cover a comparatively limited area, the phytopathological survey is more extensive, especially as regards to the chief cultivated plants. However, it is interesting to note that the principal agricultural areas of Santo Domingo devoted to cacao, coffee, tobacco, fruit trees and minor crops which include chiefly the Valley of the Cibao, the sugar cane district of the eastern part and the northwestern region under irrigation were the chief centers of investigations and thorough survey work.

Agricultural Production of Santo Domingo

Santo Domingo is by far an agricultural country. Exports during the decade 1919–1928 ranged from a minimum of $15,231,355 (in 1922) to a maximum of $58,731,241 with a yearly average of $30,208,403 of which over 99 per cent corresponds to agricultural products or products derived from agricultural industries. During the fiscal year 1928 * the percentage of exports was as follows:

* Adapted from the Report of the 22nd fiscal period, Dominican Customs Receipts (1928), Washington, 1929.

	Agricultural products %	Other products %	Total
1. Sugar and sugar cane	64. 28	------	-------
2. Cacao	14. 78	------	-------
3. Coffee	7. 43	------	-------
4. Tobacco and manufactures	4. 69	------	-------
5. Animal products	3. 47	------	-------
6. Molasses	2. 15	------	-------
7. Corn	1. 11	------	-------
8. Woods	0. 79	------	-------
9. Beans and seeds	0. 13	------	-------
10. Fruits	0. 10	------	-------
11. Shells, tannics, etc.	0. 08	------	-------
12. Dyes and resins	0. 03	------	-------
13. Other vegetable products	0. 31	------	99. 39
14. Marine products	-----	0. 02	-------
15. Mineral products	-----	0. 01	0. 03
16. (Reexports)	-----	------	(0. 58)
Total	99. 39	0. 03	100. 00

For the purpose of this survey, the author has made the following zone or area divisions of Santo Domingo.

1. Zone of the central range of mountains largely covered by extensive natural groves of pines.

2. Zone of the north range of mountains partly planted in coffee, minor fruits, and sugar cane to a very limited extent, and partly devoted to cattle raising.

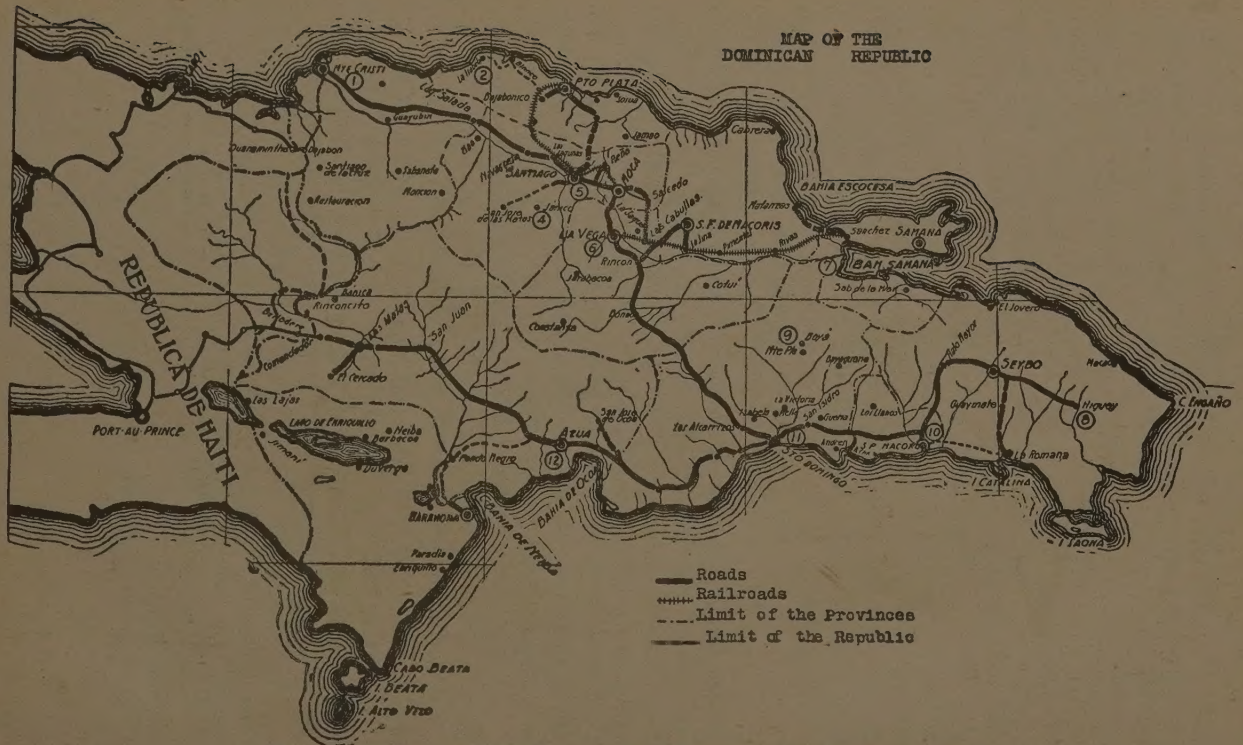
3. Valley of the Cibao, which is the most fertile area and consequently the most intensively cultivated district in Santo Domingo. It produces the largest portion of the agricultural products, not including sugar cane (especially cacao, tobacco, corn, beans, coffee, etc.)

4. Barren regions of the northwest and southwest, which formerly produced cotton and are at present devoted to hard wood, small quantities of vegetable dyes and tannics and the raising of goats.

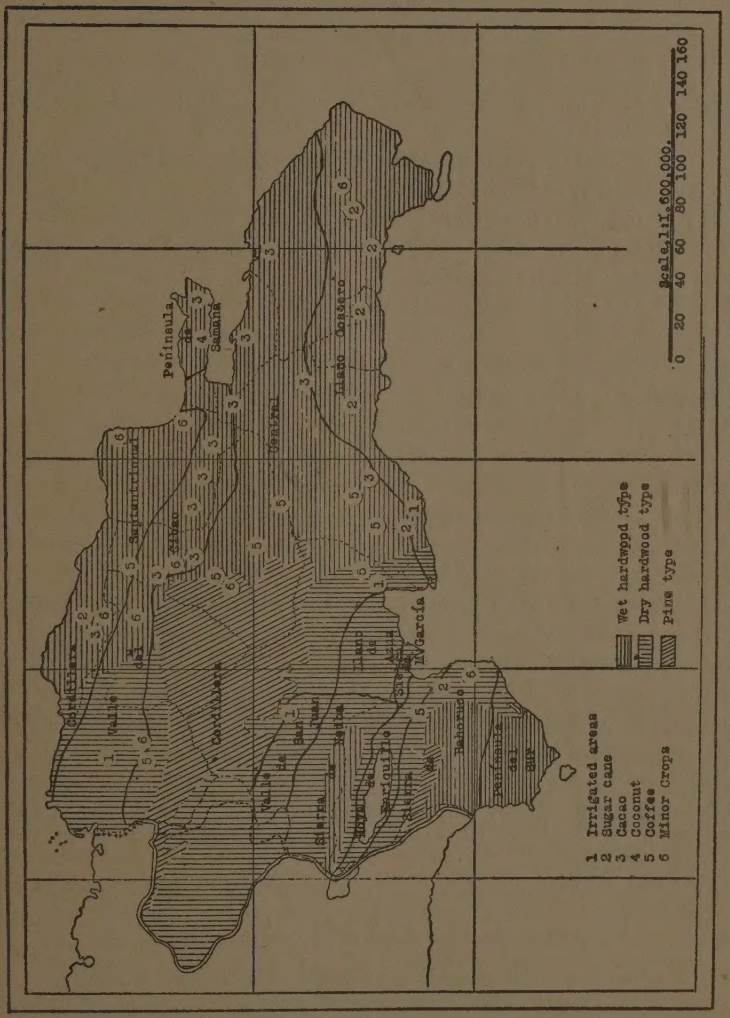
5. Irrigation areas of the northwest and southwest, chiefly devoted to potatoes, rice, onions, etc., and sugar cane in the southwest. These are sold for local consumption in the interior districts.

6. Coastal plain of the southwest where sugar cane is almost exclusively planted.

7. Sierras on the south, devoted to coffee.



MAP OF THE DOMINICAN REPUBLIC, SHOWING THE PROVINCES



MAP SHOWING FOREST AND CROP DISTRIBUTION IN THE DOMINICAN REPUBLIC

Plants and Plant Diseases

alfafa (*Medicago sativa L.*)

This forage plant has been known in Santo Domingo for a long time but has been only recently propagated chiefly in the areas under irrigation.

Leaf spot (*Cercospora medicaginis* E. & E.). Although quite common it is rather unimportant.

Root disease (*Rhizoctonia violacea* Tul.). Frequent in plantations of the Cibao valley but rarely found in regions under irrigation. It does but little damage.

Rust (*Uromyces striatus* Schr.). Widely spread during certain periods of the year. During the rainy season, particularly, the attack of the rust is so serious as to practically spoil the first harvest, although with little damage to the second harvest.

Avocado (*Persea Persea* (L.) Cock.)

Widely cultivated throughout the country but only for local consumption.

Anthracnose (*Colletotrichum gloeosporioides* Penz.). While it is spread to a good extent, in the majority of cases, it is not very injurious.

Gummosis (?) This disease is not widely distributed but is found in many plantations and is probably the most serious disease which affects the avocado. In spite of its slow progress and the fact that plants affected by the disease may live for several years, they eventually die. The disease presents the same characteristics as the gummosis of citrus plants. The removal of the diseased tissues and the application of iron sulphate gave favorable results in those cases where the disease was in an early stage, but not where the disease had reached an advanced stage. Nothing is known regarding the pathogenic agent.

Leaf spot (*Phyllosticta perseae* E. & M.) Rare and unimportant.

Banana (*Musa paradisiaca* L., subsp. and var.)

Of extensive cultivation, especially the plantain. There are a number of varieties and the cultivation thereof is gradually being fostered for commercial ends. It is only during the past five or six years that bananas have been exported, which exports have been largely limited to the plantains. This plant which is not seriously attacked by insects, is severely affected by cryptogamous diseases, especially the Panama disease.

ANTHRACNOSE (*Colletotrichum gloeosporioides* Penz.) Widely spread and very injurious although its effects may be variable.

LEAF SPOT (different fungi). On dried leaves several fungi have been recognized, among which are: *Phyllosticta musae-sapienti* Frag. & Cif., *Leptothyrium musae* Cif. & Frag., *Macrophoma musae* (Cke) Berl. & Vogl., *Sphaeropsis paradisiaca* (Mont.) Sacc., *Sphaerella musae* Speg., *Cercospora* sp., etc., whose pathogenicity was not tested and therefore it is impossible to decide which of them are the real parasites. This disease is widely scattered but appears to do little damage.

PANAMA DISEASE (*Fusarium cubense* E. F. S.) This is the most serious banana disease in Santo Domingo. Its occurrence in 1925 was limited to a heavily infested center in La Vega and other centers of minor importance in Seybo, San Cristobal, San Juan de la Maguana, Moca, Santiago, Puerto Plata and Samaná. During the period of 1925 to 1929 the disease, in spite of the campaign of eradication practised, has spread all over the Republic and it is now difficult to find a banana estate which is not more or less affected by the disease. At the present time important centers of the disease are at Villa Vázquez, San Francisco de Macorís, Bonao, San Pedro de Macorís, Baní, Cabral, Bajabonico, etc., in addition to the afore mentioned districts. Although this disease causes serious damage, it is difficult to estimate definitely the extent of same. However, it has little bearing as a national problem since exports of plantains cover only the excess over local consumption. A duplicate series of trials made in La Vega and Moca by sterilizing the infected soil with mercury-organic products gave quite favorable results. However, this method can not be put in operation economically in the Dominican Republic on account of the low prices of bananas and also because of the large areas of virgin soils available at very low prices. Although we have made careful search we have been unable to find varieties immune to this disease. However, there are some resistant forms which are generally of little commercial value. The collection and study of the different varieties is still under way. Some varieties, commonly considered as immune, did not stand the test.

ROOT DISEASE (?) Quite frequent in plantings in wet soils of poor drainage and insufficiently aereated. The pathogenic agent is unknown; a *Marasmius* sp., which is at times present appears to be merely a saprophyte of little importance.

Beans (*Phaseolus vulgaris* L.)

Among the annual crop plants with the exception of corn and tobacco, this is the most extensively cultivated plant in the Dominican Republic. Two types predominate, namely "Red Kidney" and "Pompadour", the former grown for exportation purposes is likely to surpass the latter. The damage caused to beans by cryptogamous diseases is unimportant as compared to the damage caused by insects, such as *Empoasca mali* Le Bar. This is at times well controlled by ***Beauveria globulifera*** (Speg.) Vuill.

Anthracnose (*Colletotrichum Lindemuthianum* (Br. & Cav.) Sacc. & Magn.) This is the most important of the bean diseases; the damage varies and may reach considerable proportions according to the stage of growth of the bean plant at time of attack.

Leaf spot (*Cercospora canescens* Ell. & Mart.) Of no economic interest.

Powdery mildew (*Oidium erysiphoides* Fries). Very frequent but generally of no great importance.

Pseudo mosaic (?) Widely spread. It appears to be in some way related to the attack of ***Empoasca mali.***

Root rot (*Rhizoctonia* sp.) This disease is generally of little economic interest, but may cause serious damage, especially in the provinces of La Vega and Espaillat, where during the rainy season it has totally destroyed plots of beans.

Rust (*Uromyces appendiculatus* (Pers.) Lév.) Common everywhere but of little economic importance.

Cabbage, Cauliflower, etc. (*Brassica* spp.)

Rarely cultivated, except throughout the neighborhood of towns and cities.

Bacteriosis (?) *Phytomonas campestre* (Pamm.) Comm.). Very common disease which under favorable conditions and when the plants are not properly cultivated may cause the death of 50 per cent (or even more) of the crop. The pathogenic agent was only identified by the etiological character of the disease.

Leaf spot (*Alternaria brassicae* (Berk) Sacc.) A very common disease which is quite harmful due to the fact that it impairs the quality of the product.

Cacao (*Theobroma* spp.)

For exportation purposes cacao is considered the second product in order of importance. Its range of cultivation covers practically

the total area (about 90%) of the Cibao district in the provinces of Espaillat, La Vega and Duarte. The average annual production is almost constant and the extension of plantings is slowly decreasing, since this crop is gradually being substituted by coffee. The phytosanitary conditions of cacao, as a general rule, are poor. Although this plant is not affected in Santo Domingo by epidemics of severe nature, neglect in its culture usually results in serious losses. This is especially true if in addition to diseases of cryptogamic origin the plants also suffer from the attacks of the *Heliothrips rubrocinctus* Giard, rats and the bird, *Chryserpes striatus* Mill. Consequently, the phytosanitary problem of cacao in the Dominican Republic is largely of an agricultural nature. If a systematic cultivation were followed and the plant received the proper technical attention, the damage caused by cryptogamous diseases and by the above referred to insect would be greatly ameliorated. It would avoid the expensive cost of the direct control of the diseases which at present leaves only a very narrow margin of profit to cacao growers.

In the Reports published by Dèscombes (**11**), he pointed out that he discovered in cacao plants along the coast of Samana Bay a *Stromatinia* (the illustration and description of which are identical with a *Monilia* sp.) as the possible cause of the death of the plants. The writer investigated the cacao estates of this region to ascertain a possible relationship to the *Monilia* of Ecuador (although the etiological characteristics were found at variance) and succeeded in discovering and isolating the fungus which was a true *Monilia* sp. The inoculation tests made by the author were always negative, the death of the plant being caused by the "root diseases" jointly with the attack of the *Heliothrips rubrocinctus,* the lack of shade and by the brown rot. The result of these experiments as well as a description of some leaf parasites was separately published by the author (**5**).

Black rot (*Phytophthora Faberi* Maubl.). Although this disease is rather frequent it is not very injurious. Furthermore, a great variation is noticed in the plants in their resistance, not only in the various groups or varieties (the Calabacillo group presents the highest resistance, while the Criollo group is the most susceptible) but also in the individual plants, and we are of the opinion that through proper selection it might be possible to obtain resistant types of cacao.

Brown rot (*Diplodia theobromae* (Pat.) P. Henn.) Among the cacao diseases whose local effects have been reported, this is un-

doubtedly the disease which is largely responsible for the reduction of the crop, the most common type of the disease being the rot of the pod. The fungus develops and sporulates abundantly on the shells of ripe pods left over to rot on the soil after removal of the beans. The fungus lives in the old shells as a semi-saprophyte. We believe that this is the way in which the fungus maintains itself from year to year. Therefore, we have recommended the burying of the shells of all pods, both healthy and diseased and applying quick lime in the hole where they are buried. This simple practice has considerably decreased the percentage of infection in Barahona where the disease had been reported as serious.

Canker (*Phytophthora Faberi* Maubl.). Quite frequent and somewhat injurious but not as serious as the root and pod rots.

Chlorosis (Various causes). This is a general symptom of disease which may be ascribed to various causes, lack of nutrition, canker, root diseases, etc. On several occasions we have observed that on soils which are calcareous-humic, or humic with calcareous sub-soil, plants usually become chlorotic and the root system is more or less injured. Experiments made by applying lime in the soil in which adult plants were growing will have caused a temporary chlorosis in the majority of cases (22 out of 26 treated), but within the course of from three to eleven months the symptoms disappeared.

Damping-off (*Phytophthora Faberi* Maubl.). This is said to destroy not less than one third of plants growing from seeds planted directly in the field. It is generally estimated that out of three seeds planted, one at least dies. The critical stage of the plant is when it grows to about eight inches; the leaves wilt rapidly and in the course of two, three or even eight or ten days they turn yellow and fall off. The lower portion of the stems shows a brown spot which rapidly spreads around and forms a ring; the bark is destroyed and the plant dies within a few days. This spot is likely to appear in any place on the hypocotyledonary axis. From the dead plants we succeeded in isolating a *Fusarium* sp. the inoculations with which gave negative results and a *Phytophthora* sp., probably related to *P. Faberi* Maubl., which when inoculated in sterilized soil, communicated the disease in 32 per cent of cases. The disease is more serious during the season of heavy rains and in soils which are extremely clayey, without drainage or with poor drainage.

Dusty mold (*Actinomyces albus* Kr. emend. Waksm. & Curt. and *Actinomyces* spp.). While this is not really a disease since it repre-

sents the action of microorganisms which grow in the rind of the dry beans, this mold is still the object of investigations and a preliminary study of it has been published (4). The spores of the *Actinomyces* are carried from the shell of the pods to the beans chiefly by the hands of laborers. Further contamination takes place in the fermentation vats and in the drying sheds. The spores remain dormant while said processes take place, but it is chiefly during transportation in the hold of a ship where it is damp and warm, especially, that the spores germinate and the fungus becomes active. Cacao then takes a peculiar and disagreeable odor known as "mold odor".

Shedding and Other Anormalities of Flowers (physiological causes). These diseases are harmful; however, it is desirable to investigate different cases. Abnormal proliferation of the flowers which are commonly sterile and known under the name "male cacao", is rather frequent; it is partially due to unknown physiological causes and is the most important of these diseases.

Internal Black Mold of Pod (*Aspergillus fumigatus* Fres.). Rather unimportant from a practical point of view, either because it is not a common disease or because it is almost exclusively confined to the small cacao estates in the San Cristóbal district along the southern coast of Santo Domingo. It is however, of great interest from a scientific point of view. The *Aspergillus fumigatus* makes its entrance through the shell and rapidly invades the whole fruit, preventing the pod from ripening, or injuring the beans in the case of ripe fruits. The exterior shows a diseased appearance only after the disease has reached an advanced stage and is detected easily by selecting the fruit. The inoculation experiments practiced verified the possibility of infection through the wounds, although with a limited percentage of positive results. There was no infection without injury or by floral contamination.

Knot or Galls (?) Discovered only in Moca and San Francisco de Macorís. The woody galls may develop to the size of an egg, or even larger. They grow isolated in the branches and their bark is rough. They do not appear to be caused either by the *Sphaeropsis tumefaciens* Hedges or by the *Bacterium tumefaciens* E. F. S. Galls of a more or less hemispherical shape are easily detected on trunks attacked by a *Pseudococcus* sp. and there is a possibility that their occurrence may be in some way connected with the parasitism of this insect.

Leaf spot (*Phyllosticta theobromae* D'Alm. & S. da Cam.). A very common fungus, but of little economic importance. It attacks

principally the scorched or old leaves or those attacked by the *Heliothrips rubrocinctus*. It is also found in a local form of little systematic value and together with three other fungi, which probably are of limited pathogenicity; (*Physalospora theobromicola* Frag. & Cif., *Septoria theobromicola* Cif. & Frag. and *Leptosphaeria theobromicola* Cif. & Frag.) (5).

PINK DISEASE (*Corticium ? salmonicolor* B. & Br.). Does not appear to be common, and is economically unimportant.

POD MUMMIFICATION (?) Very frequent; the nature of this disease is unknown. The young and tender pods turn dark, shrink and dry up in the course of a few days but remain attached to the stem of the plant. The disease is characterized by drying and mummification of the fruit; but there is no soft or wet rot. This peculiarity, in addition to the absence of the parasites above referred to (with a few exceptions of superposition), distinguish this disease from the brown rot and the black rot. This disease attacks only the very tender pods (of one or two inches, rarely of three inches in length), while the other two pod diseases attack the mature or ripe pods. We have been unable to discover parasites of a cryptogamic nature; the saprophytes which are common in the pods attacked by the other two diseases are very rarely present in this disease. We are of the opinion that the disease is of physiological origin and it is probably due to malnutrition of the plant which, consequently, is physically unable to ripen all the mature pods. A series of observations made on the number of mummified fruits on plants under different conditions of environment and age, and during several years, have confirmed our hypothesis.

RED RUST (*Cephaleuros virescens* Ktze.) Common everywhere but of no great importance, except when cacao leaves have been badly infested, which ususally takes place in plantations in poor growing condition. The same may apply to leaf lichens, bark lichens and mosses and other epiphytes found upon cacao.

"RONCET" (?) This disease which is very interesting from a scientific point of view, is economically unimportant. At least, for the time being, it spreads slowly and with difficulty. It is really infectious; so far, it has been found in a few cacao plantations in the province of Santiago toward Puerto Plata. It is of a doubtful nature and the development of the disease is so slow that it requires a number of years before it causes the death of the plant; normally this may occur in a period of two years, but sometimes a longer period is required. Some of the plants affected by the disease late

in 1925, are still alive. This slow development renders it difficult to form a definite idea as to the symptoms and progress of the disease. The preliminary symptoms are therefore, unknown to us. When the disease reaches an advanced stage the most apparent symptom is a reduction in the number of leaves which are generally grouped together on the tips of branches. The leaves which at first may be normal in color and size, gradually shrivel in the spaces between the veins and as a general rule the corrugations are convex toward the upper surface of the leaves and concave in the lower surface. Frequently the leaves twist and bend. At the same time there is an irregular tooth-like appearance in the edges of the leaves. These assume various shapes and even more or less irregular notches are formed. Later an uneven discoloration may take place in the spaces between the veins and in fact a general chlorotic condition may be reached. The young sprouts likewise take an abnormal appearance; they grow very little and have very small leaves which never reach normal size. During the period of vegetative growth, comparatively long and thin twigs may be formed somewhat similar to those of "witch's broom" bearing here and there a few small leaves which never develop properly. (Plate I, Fig. 4). The twig dries and the vegetative reserve is confined to a few groups of leaves in the old branches. When the wrinkled leaves appear the plant has already stopped bearing. Although it may still produce flowers, these do not produce fruit or if they do, the young pod becomes mummified. However, the spread of the disease, as already mentioned, is very slow and irregular. The disease appears in neglected and poorly cultivated cacao plantations in which a few sporadic plants may be attacked by the disease. Growers report it as contagious but in a rather irregular manner; however this has not been verified by experiments. During three years we have kept a record of the number of plants attacked by the disease in a cacao plantation near Santiago and found five diseased plants in 1926; six diseased and two dead in 1927, and five diseased and four dead in 1928. The inoculation tests made by grafting diseased stems on healthy plants and by the inoculation of the juice obtained through maceration of diseased leaves, into the petioles and central veins of healthy leaves (adult and young) gave negative results. The numerous diseased twigs grafted to healthy stock did not develop, with the exception of one which died shortly afterwards and whose vegetative characters appeared to present the same symptoms as the twigs on diseased plants. (Plate I, Figures 1, 2, and 3 are illus-

trations of three stages of the disease.) In all probability this complex disease is of a degenerative type. It reminds us, *mutatis mutandis,* of the grape disease known in Europe as "roncet" or "cort-noué", whose nature is still unknown.

Root diseases (*Rosellinia* sp. and *Rhizoctonia* sp.). Among the cryptogamous diseases with general effects on cacao in Santo Domingo, the root diseases are probably the most destructive. While at first sight the symptoms appear uniform, it is possible to differentiate a large number of root diseases, the study of which is vast and complex. There are four types of root diseases affecting cacao in Santo Domingo. The first type, "Rosellinia root disease", which is the most widely spread and destructive is due to a *Rosellinia* sp. and probably caused by *R. pepo* Pat. The damage varies and may even cause the destruction of a large number of trees. Under environmental conditions favorable to the development of the disease it may spread rapidly, although sporadically. From an infested center of three diseased plants in a very neglected plantation sixty three trees died in the course of fourteen months. The alkalinity of the soil or sub-soil, which is altogether unfavorable to cacao, seems to be a predisposing factor.

A second type of root disease is supposed to be due to a *Rhizoctonia.* This may be the same as a disease reported from the British Antilles as due to *Sclerotium Rolfsii* Sacc. Inoculation of this fungus in soil of cacao seed beds gave a low percentage of infection (less than 2 per cent). A direct inoculation into young plants about three feet high caused the death of approximately 5 per cent of the plants. It is possible that conditions for infection were unfavorable. This disease is not as common as the "Rosellinia root disease" and that reported from the province of Duarte.

A third type of root disease may be designated "dry rot disease". The general characters are identical with the preceding, but the root does not present mycelium of the type *Dematophora* of the *Rosellinia* or the white mycelium and sclerotia of *Rhizoctonia.* Furthermore, a great majority of the rootlets die while the larger roots can long resist the disease whose course is slower than other root diseases, and does not appear as serious as these. The cause of the disease is unknown to us; however, a *Fusarium* sp. was isolated which we believe does not cause it. We are of the opinion that there is a close relation between the endotrophic mycorrhiza of cacao and this disease which usually appears in heavy soils, whether wet or

not, but improperly cultivated and poorly aereated. A number of cases which appeared in San Francisco de Macorís were given a good pruning; the soil around the diseased plants was cultivated with the use of harrows, and these measures resulted in the recovery of most of the plants.

The fourth type known as "water root disease" appears in districts which are periodically flooded; or in low level places or basins without drainage in which case the rot of both the rootlets and roots takes place as far up as the stem of the tree; but there is no evidence of mycelium of parasitic fungi. This stage of the disease is the most characteristic. It does not have the nature of an epidemic and its spread is only effected under favorable conditions.

Saprophytic pod rot (different fungi). It is important in cases of wounds made by the attack of the bird *Chryserpes striatus*, by rats and, occasionally, by fruit-eating bats. If the wound is made in pods which are about to ripen, the quality of the beans is poor. When they are mixed with other beans, they contribute to make the quality of the crop inferior.

Sun scald (physiological causes). In evidence in plants without shade or with deficient shade, but generally does not affect the young leaves, whose very slanting position might be considered as a heliophobic adaptation, also suitable to high precipitation. The disease is not serious. It is possible to discover, occasionally, the *Helminthosporium theobromicolum* Cif. & Frag., morphologically different from *H. theobromae* Turc., which does not appear to be parasitic, in addition to the three fungi which live with the *Phyllosticta theobromae*. Normally the damage caused by the *Heliothrips rubrocinctus* is attributed to this disease.

Cashew-nut (*Anacardium occidentale* L.)

While largely propagated, its cultivation is not the subject of industrial exploitation, and its commercial value is restricted to domestic needs.

Anthracnose (? *Colletotrichum gloeosporioides* Penz.). Not widely spread and although this fungus has been repeatedly found in the petiole, we are not sure that it is the real cause of the disease.

Fruit fall (physiological causes). It occurs sporadically and is of little importance. We might mention that artificial infections of *Thielaviopsis paradoxa* (De Seynes) v. Höhn. gave positive results.

Cassava (*Manihot manihot* (L.) Cock).

The cultivation of this product is on the same level with sweet potatoes, both as regards to extension and importance, as well as in regard to cryptogamous diseases. The *Dilophoneta ello* L., usually causes the greater damage.

Anthracnose (*Gloeosporium manihotis* P. Henn.) Very rare and unimportant.

Leaf spot (*Cercospora Henningsii* All.). Very common but of little interest because it ordinarily attacks adult or old leaves.

Soft rot (?) Similar to that of sweet potato but more frequent: it is quite important and causes serious losses in heavy soils.

Citrus plants (*Citrus* spp.)

Although citrus plants in Santo Domingo are extensively propagated, their cultivation is of little economic importance. This is also true of other fruit trees.

Anthracnose (*Colletotrichum gloeosporioides* Penz.). Does not appear to be very common. It attacks severely the young twigs, the buds, the leaves and sometimes the fruit.

Black rot (*Alternaria* sp.) This disease is quite frequent, possibly more so than the fruit rot, but of little economic importance.

Dodder (*Cuscuta americana* L.) The attack of this parasite on citrus plants is extremely rare, in fact we have only once succeeded in finding it.

Foliocellosis (?) Quite common but unimportant.

Mistletoe (*Phthirusa* sp.) These parasites are not frequent and are of little importance.

Fruit rot (*Penicillium digitatum* (Pers.) Sacc.). Comparatively frequent; however of no great importance due to the fact that the fruits are disposed of immediately after the harvest.

Greasy spot (?) Not frequent and consequently of no interest.

Gum disease (?) This is probably the most injurious disease. The most common form of gum disease discovered by the author is the foot rot. Wild orange trees appear to be more resistant to the foot rot than cultivated citrus trees.

Melanose (*Phomopsis citri* Fawc.) Uncommon and harmless.

Pink disease (*Corticium ? salmonicolor* B. & B.). This disease exclusively attacks plants growing on coffee and cacao plantations which are exceedingly wet. It is serious.

Phomopsis rot (*Phomopsis* sp.) Less common than the preced-

ing and more widely spread in the south than in the interior of the country.

PHYLLOSTICTA leaf spot (*Phyllosticta longispora* Mc Alp. and *P. auranticola* (B & C.) Sacc.) It is spread to a limited extent but is unimportant. The *Chaetophoma citri* Sacc. is frequently found in the same lesions.

RED RUST (*Cephaleuros virescens* Ktze.) Very common on weak plants or on plants growing under excessive shade or in very wet places. Of as little interest as the leaf lichens.

ROOT DISEASES (*Rosellinia* sp.) Not a frequent disease, the cause of which was determined in but one instance.

SCAB (*Sphaceloma Fawcettii* Jenk.) Very common; not less than 50 per cent of the cultivated plants are affected by this disease, which generally attacks sour oranges and grapefruits.

SEPTOBASIDIOSE (*Septobasidium lilacinum* Burt. and *S. spongia* (B. & C.). Pat.). Very widely spread; it attacks extensively the young twigs, the petioles and leaves, and even the fruit. It is associated with a coccid, but in itself is of little economic interest.

SOOTY MOLD (*Capnodium citri* B. & C.) Widely spread and associated with different Coccidae, but of no importance.

THRIPS INJURY. The author has discovered frequently associated with a *Thrips* sp. a mycelium of Dematiaceae, generally with no conidia, but occasionally with conidia of *Cladosporium* sp. similar to *C. citri* Br. & Farn. (different from *C. citri* Massee) which darkens the light spots produced by the Thrips.

THREAD BLIGHT (*Corticum koleroga* (Cke.) v. Höhn.) This fungus is reported to attack citrus plants exclusively. The writer has discovered it on plants growing among coffee and cacao plantings which were attacked by this disease. It is of no importance.

TWIG BLIGHT (? *Diplodia* sp.). The existence of this disease was not definitely ascertained, in spite of the fact that a *Diplodia* was discovered on several occasions on twigs affected by anthracnose.

COCONUT (*Cocos nucifera* L.)

Although growing everywhere in the plains of Santo Domingo, its cultivation is not as important as it might be. It is cultivated in the south coast of the Peninsula of Samaná, and to some extent along the coasts of the Caribbean Sea and the Atlantic Ocean. The damages caused by cryptogamous diseases are doubtless of less intensity than that caused by the *Aspidiotus destructor* Sign., a serious enemy of this palm, and partly by the *Homaledra sabulella* Chamb.

Bud rot (*Phytophthora palmivora* Butl.) A very rare disease which, although it has been occasionally discovered in different places has the tendency to be localized or to spread very slowly. It was reported in Cibao (Moca and Santiago), in Samaná and Monte Cristi, but was not found anywhere else. It was closely watched for in those places during the years 1925 and 1926 to ascertain the extent thereof. The two cases discovered in Monte Cristi were checked and there was no recurrence of the disease. On the contrary, in Moca and Santiago, where the cultivation of coconuts is of no importance, the disease appeared to spread very slowly. There were found in each province one case in 1925; in 1926 one case in Moca and two cases in Santiago. In 1927 two cases were discovered in La Vega which were not reported in 1928 and three in Santiago during 1927. In Samaná the number of palms affected is equally rare; five cases were identified in 1925 and seven in 1926. In the southern coast and Puerto Plata no cases have been reported to date. We are unable to explain the cause of the slow spread of this disease which ravages coconut plantations in the neighboring island of Cuba and is quite common in Porto Rico.

Fruit drop (?) This disease which makes its appearance at certain times, may be due to non-parasitic agents, although we have found a *Diplodia* sp., especially on the petiole. The falling of the young fruits is most abundant when they have reached a diameter of one or two inches.

Leaf blight (*Pestalozzia palmarum* Cke.) Common over all the Republic, but of no economic importance.

Trunk rot (?) Very rare and of unknown origin.

Coffee (*Coffea arabica* L.)

Although the cultivation of coffee dates back to an early period, it is only during the last five or six years that it has increased considerably. There is no doubt that at the present time coffee is the crop which is being most rapidly extended in the Republic. It has become recently the third or fourth product in order of importance as far as exports are concerned, and it is expected that in the course of a few years it will be on a level with cacao and may even surpass the latter. The damages done by cryptogamous diseases of coffee are probably of minor importance as compared with the damage caused by insects, particularly the *Coccus viridis* Green and the *Leucoptera coffeella* Guér. Coffee is grown throughout the mountainous regions, but without uniformity.

We might mention that the leaves of young plants of *Coffea excelsa* Chev. have been attacked by the *Dyctyothyriella mucosa* (Syd.) Syd., but the disease has not been found on *Coffea arabica.*

Berry rot (?) A common disease, rarely injurious. The causes have not been determined although several fungi have been found on the berries. Before ripening, the berries show wounds or irregular lacerations and the fruits fall before they ripen fully. This disease is generally independent of the attack of *Cercospora coffeicola.*

Leaf rot (*Pellicularia koleroga* Cooke). Not common and of no importance, except in coffee plantations in the vicinity of Bonao where the disease was widely spread and caused more damage than in other places.

Leaf spot (*Cercospora coffeicola* B. & C.). More important and more abundant than the eyespot although its behaviour varies according to the district and time. We have observed that it is more injurious in the provinces of Espaillat and Azua where it attacks both berries and leaves, while in other places it is the reverse. In general it can not be considered a destructive disease.

Root diseases (different causes). Among the cryptogamous diseases of coffee in Santo Domingo, this is the most serious, although the damage caused varies according to the place and time. As in the case with cacao there are various root diseases grouped under the same name which would seem to be due to different causes, even though the symptoms or effects on the plants may appear analogous or identical.

The first type is the "Rosellinia root disease" or "Black root disease" which appears to be the most harmful and widely spread. We have not determined the species of Rosellinia save in few cases where we have found it to be *R. pepo* Pat. The second type, not as frequent as the first, and found principally in Barahona is the "Rhizoctonia root disease" or "White root disease", whose characteristics are similar to the preceding, except for the presence of mycelial hyphae which are white instead of dark or black. Two different species, not identified, were isolated and inoculated in sterilized soil where there were young plants of from one to two years of age. The soil was black, humic and acid (pH 5.6). The percentage of infection was exceedingly low: less than one per cent. The experiment was again made on soil of pH 5.0 with practically the same result, i.e one per cent infection. A third experiment was made on calcareous clay soil, (pH 7.8) where the plants were transplanted. The percentage of dead plants was very high reaching

80 per cent and the majority showed the same symptoms observed in infected coffee plantations. Further tests, still unpublished, have proved that an acid soil is indispensable for the normal growth of coffee; a neutral soil is unfavorable and a small alkalinity is decidedly harmful. The plants vegetate slowly and with difficulty and show a more or less serious chlorosis. Under these conditions they are easily attacked by root diseases and especially the "dry root diseases." *

A series of further experiments on coffee plantations demonstrated that where root diseases were more severe and coffee vegetated with difficulty, bearing sparingly, and dying without any definite causes ("dry rot disease"), with a destruction of the young rootlets while there was no rot of the old roots; the hydrogen-ion concentration of the soil was greater than pH 6.6–6.8. Under such conditions the development of endotrophic mycorrhiza is great; as a general rule, it may be easily demonstrated by the Janse reaction. However, we have been unable to prove definitely that the *Rhizoctonia* which represents the root endophyte is the same one with pathogenic action, even though there are a number of indirect reasons for our assumption. The fluid of the liquid culture of the rhizoctonia-endophyte demonstrated, *in vitro,* a decisive pathogenic action on sections of young and healthy rootlets. A paper will be published later in connection with the root diseases of coffee and cacao.

Sooty mold (*Capnodium ? coffeae* Pat.). Associated with the attack of scale insects, especially *Coccus viride.* Of no importance although we have seen cases in which all the plant was covered with a thick black coating.

Eye-spot or "Viruela" (*Stilbella flavida* (Cke.) Lindau). Of no great importance, although wide-spread.

Corn (*Zea Mays* L.)

The production of corn in Santo Domingo which, until recently, was for the small local consumption has rapidly increased during the last few years and corn is now also grown for purposes of exportation. The so-called "Francés grande", which has been improved gradually is the type most widely propagated and cultivated. Corn is not seriously affected by cryptogamous diseases. Far more

* This is probably the same disease which in other countries has been doubtfully ascribed to Basidiomycetes.

injurious to this crop are the Lepidopterous insects (*Laphigma frugiperda* S. & A. and *Heliothis obsoleta* Fabr.)

Rusts (*Puccinia purpurea* Cke. and *Uredo pallida* (Diet. & Holw.) Arth.). Of no great importance, although these two fungi are very common on mature and old leaves.

Mosaic (?) Comparatively frequent, but causing no important damage.

Smut (*Ustilago zeae* (Beckm.) Ung.) After a close search in corn plantations some cases of smut are almost invariably discovered, but this disease is of little importance. The damage due to this disease was less than ¼ of one per cent with the possible exception of some very occasional cases.

Spike top rot (?) This disease is due to one or two species of bacteria. It develops only on young ears, which are not yet ripe, but which have been attacked by the larvae of *Heliothis obsoleta*. Subsequent to their attack it is possible that larvae of unidentified Diptera may develop, which in all probability, disseminate the bacteria. Even though we are unable to prove our assertion our opinion is based on our observation that this disease is constantly associated with the presence of larvae of Diptera and, consequently, associated with the attack of the *Heliothis obsoleta*. The end of the ear softens and rots, developing a yellow or dark color as the rot extends from the tip to the base. Normally the infection is confined to one inch but may spread practically all over the green ear, especially if it is still quite young. The affected part is unable to produce grains but the portion not affected ripens normally. Therefore, the damage caused by the disease varies greatly according to the intensity of the attack. If it is confined to the tip of the ear, as is usually the case, it is not important because the grains at the tip even under normal conditions, do not mature properly. In the other case the damage may be serious. At first we were of the opinion that the disease was caused by a saprophyte, since it was not transmitted by grafting small pieces of the ear, or by inoculating the tip of the healthy ears with an infected needle. However, having inoculated with bacteria by puncturing into the healthy culm of a series of corn plants, we have often obtained (11 out of 36 cases) the formation of a blackish necrotic zone which extends in a circle from the point of infection, and length-wise for about one half inch. The ears of the infected plants did not ripen and after a few days (7 to 15) the culm dried from the point of inoculation upwards. We have observed that a rainy season favors

greatly the development of this bacteriosis which is seldom recognisable in dry weather, although the attack of the Heliothis may be serious. The early infection is more destructive than the late infection. The estimated average damage in experimental plots of the Station was about five per cent.

Cotton (*Gossypium* spp.)

Its cultivation which is almost exclusively confined to the province of Monte Cristi, is at present in a very neglected condition. This is due to the great damage caused by the *Pectinophora gossypiella* Saund., which is the most destructive pest of cotton in the Republic.

Angular leaf spot and bacterial wilt disease (*Erwinia malvaceara* (E. F. S.) Comm.). A very common disease and apparently rather serious.

Anthracnose (? *Diplodia gossypina* Cke., ? *Colletotrichum gossypii* Southw.). Could really be considered as two different diseases but they have not been clearly differentiated in connection with the pathogenic agent and the etiology. Not very injurious.

Areolate leaf spot (*Ramularia areola* Atk.) As the preceding.

Internal boll disease (*Ashbya gossypii* (Ashby & Now.) Guill.) Found in Haina on buds of an spontaneous hybrid of *Gossypium hirsutum* x *G. barbadense*. Probably the disease may be more widely spread.

Mouldy boll disease (different species). This seems to be the most common of boll diseases and together with bacterial boll disease causes at least from five to ten per cent damage. The injury to bolls appears to be caused by different saprophytic fungi which have not been thoroughly investigated.

Rust (*Kuehneola gossypii* (Lag.) Arth.). Very common but rarely injurious.

Eggplant (*Solanum Melongena* L.)

The cultivation of this plant has more or less the same range as that of tomato. It is less affected by cryptogamous diseases than tomato and suffers more from the attack of insects.

Concentric fruit rot (*Phomopsis vexans* (Sacc. & Syd.) Hart.) It is the most harmful cryptogamous disease that attacks the eggplant. The degree of intensity varies considerably, and may cause the total destruction of the crop in times of high humidity. It is

spread throughout Cibao. The attack on the leaves is of minor interest.

LATE BLIGHT (*Phytophthora infestans* (Mont.) de By.). This disease is seldom seen and is not clearly identified; it is of no economic interest.

LEAF MOLD (*Cladosporium fulvum* Cke.) Same as the preceding.

LEAF SPOT (? *Phyllosticta hortorum* Speg.) Apparently very common; it is injurious during the wet season but unimportant at other times. The pathogenic agent was not definitely identified.

SPOTTED FRUIT ROT (*Gloeosporium melongenae* E. & H.). This parasite is frequenty associated with the fruit rot. It predominates in southern plantations rather than in Cibao where apparently it is less harmful.

GUAVA (*Psidium Guajava* L.)

This plant, generally speaking, is not cultivated except for a limited propagation of a number of sweet varieties. The commercial exploitation is confined to the wild varieties. The cryptogamous diseases are of no economic interest.

FRUIT ROT (*Gloeosporium psidii* Del.) Very common but of little importance.

SILVER LEAF DISEASE (?) A very interesting disease from a scientific point of view which we have discovered only in Haina. The causes are unknown. The leaves of a diseased plant are generally of a silvery color. The plant does not bear, or bears sparingly, but ordinarily does not die.

LETTUCE (*Lactuca sativa* L.)

Very rarely cultivated.

DAMPING-OFF (*Pythium de Baryanum* Hesse). While it is quite common in seedbeds, it is not very harmful.

LEAF SPOT (*Cercospora longissima* Sacc.). Frequently attacks old leaves and therefore is unimportant.

LIMA BEAN (*Phaseolus lunatus* L.)

Grows throughout the country and is cultivated to a limited extent for local consumption.

ANTHRACNOSE (*Colletotrichum Lindemuthianum* (Sacc. & Magn.) Br. & Cav.) Rare and of no importance.

Root rot (*Rhizoctonia* sp.). Similar to the same disease affecting beans.

Mahogany tree (*Swietenia mahogani* (L.) Jacq.)

This tree is widely distributed throughout the country. Although it predominates in the semi-arid regions of the south and northwest, where it appears to be gradually losing ground and in certain places has entirely disappeared. A survey was made for the purpose of ascertaining the causes for the decline of this tree but it has not been published.

Leaf spot (*Pestalozzia swieteniae* Cif. & Frag.) This disease was found only in seed beds of the Agricultural Station in Haina. It is not very serious.

Mistletoe (*Phoradendron Haitiense* Urb.) * Very common but apparently does little harm.

Meliola leaf spot (*Meliola swieteniae* Cif., n. sp. ad. int.) Found in southern coast, apparently rare and unimportant.

Malanga, Taro, etc. (*Caladium* sp.; *Xanthosoma* sp.)

These plants grow extensively but are rarely cultivated, and are of no commercial importance.

Internal rot (?) A sporadic disease which at certain times and places causes serious damages in plantations. The characters of the disease correspond to the so-called "mal de la malanga" (taro wilt) in Porto Rico and probably to the disease which in Jamaica is ascribed to the *Vasculomyces xanthosomae* Ashby, but we have had no occasion to investigate it thoroughly.

Its presence was reported sporadical and serious in the provinces of Duarte, Puerto Plata and Espaillat.

Leaf spot (?) Very common but unimportant.

Soft rot (*Erwinia carotovora* (Jones) Comm.). The rot of the rhizome of this plant was induced and it was experimentally reproduced on *Alocasia macrorrhiza, Colocasia antiquorum, Caladium Schomburghii* var. *pictum, Iris germanica, Daucus carota, Hyacinthus orientalis, Lycopersicum esculentum, Zantedeschia aethipica* and *Gladiolus hybridus* (5).

Mango (*Mangifera indica* L.)

This tree ranks with the avocado in importance but it is more widely propagated.

Anthracnose (*Collectotrichum gloeosporioides* Penz.) It is the most serious disease of the mango and causes the loss of a consider-

* Reported by Dr. E. E. Ekman.

able amount of fruit, especially if the attack of the disease is severe before the fruit ripens. It is less injurious to leaves.

Fruit rot (*Diplodia mangiferae* Koord.) A rot of the fruit which is less common than the anthracnose, with which it may be associated. The fungus lives on the leaves with difficulty. It is probably the same species previously designated *Lasiodiplodia* sp., *Lasiodiplodia theobromae* (Pat.) Griff. & Maubl. and *L. tubericola* E. & E. Apparently it is not wide-spread or very harmful. During the summer of 1929 there was reported in Samaná, near Sabana del Mar, the attack of a *Phytophthora* sp. which destroyed about 50 per cent of the crop. The fruit was affected before ripening. This disease which is still the subject of study and investigation has not since been rediscovered and we might mention that it had not been reported prior to 1929.

Mangosteen (*Garcinia mangostana* L.)

Recently introduced and its cultivation is confined to a few plants.

Anthracnose (*Gloeosporium mangostanae* Cif.). Different from the *Gloeosporium garcinia* Koord. It is in all probably a leaf parasite. It is so rare that it has been impossible to determine its true nature. Like the former, this fungus does not affect the *Garcinia tinctoria* (DC) Dawn. (5).

Leaf spot (*Pestalozzia Espaillati* Cif. & Frag.) It is frequently found on the apex of dry leaves. Inoculation experiments gave negative results (5), both in tests with *Pestalozzia clusiae* Griff. & Maubl., which lives on leaves of *Clusia rosea*, of the same family and which we presume is adaptable to the mangosteen, and the *Pestalozzia canangae* Koord. of the "Ylang-Ylang". This species is probably a secondary parasite which lives upon leaves of plants affected by the root disease. The *Pestalozzia Espaillati*, common upon *Garcinia mangostana* was never found to attack *Garcinia tinctoria*.

Root disease (?) The most common and harmful disease which destroys over 90 per cent of young plants in seedbeds; the cause of the disease is unknown to us.

Mulberry (*Morus* spp.)

Although this tree formerly existed in the island, its propagation dates from the last three or four years, in connection with the possibility of fostering the silk-worm industry.

BACTERIOSE (*Phytomonas mori* (Boy. et Lamb.) Comm.) This disease has not been definitely identified and has been found only in Moca.

OKRA (*Abelmoschus esculentus* (L.), Moench.)

Common throughout the country but rarely cultivated.

FRUIT ROT (?) A common disease which is quite serious during rainy seasons.

LEAF SPOT (*Cercospora hibisci* Tr. & Earle.) Quite common, but causing little damage.

ONION (*Allium Cepa* L.)

The systematic cultivation of this plant for commercial needs is of recent date and prevails in the irrigation districts, but it is grown throughout the country on a small scale. In addition to some serious cryptogamous diseases, it is also attacked by a serious pest, the *Thrips tabaci* Lind. The latter is an important factor in the reduction of the crop which can thus be obtained only at a certain time of the year.

BACTERIAL ROT (*Erwinia carotovora* (Jones) Comm.) It is found only in the clay soils of Cibao during the rainy season and is very severe. This disease was not discovered in Santiago, Monte Cristi and San Juan de la Maguana.

LEAF SPOT (*Alternaria porri* (Ell.) Cif.) This is the most serious cryptogamous disease that attacks onions in Santo Domingo. Its damage shows great variability, and the general average may be estimated at not less than 10 per cent and very often higher. The preventive measures for this disease have been thoroughly investigated, and the use of the mercury-organic compounds or Bordeaux mixture have been most effective if applied freely as a prophylactic. As a matter of fact, the most serious attacks result from the time of the transplanting of the young plants to the time when the plants have grown approximately five or six inches. The control of the disease is of minor importance due to the fact that late infections are not serious. The systematic position of the fungus which causes the disease was the object of investigation which proved rather complicated. We have excluded the *Macrosporium parasiticum* Thuem., which was frequently present because the inoculation tests were always negative. The disease has been reproduced both by *Alternaria alli* Nolla and by *Macrosporium porri* Ell. The disease is hardly recognisable. The same may be said regarding its morphological, biometric

and cultural characters in the cultures with the exception of mutation and aberrant. forms. Therefore the two species appear to be identical and if we admit the validity of the genus *Macrosporium* with the denomination of Nolla, the fungus should then be known as *Alternaria porri* (Ell.) Cif.

Papaw (*Carica papaya* L.)

It is widely propagated, but its cultivation on a small scale is of no economic importance.

Curly leaf (?) This disease is largely spread throughout Cibao, chiefly in the interior as far as the Province of Samaná where it was first discovered. Its characteristics are very evident, but the causes thereof and its etiology are still uncertain. The disease generally affects old plants even though it may occasionally attack young plants. The first visible symptom is a curling of the younger leaves which gradually twist to form "cushions". At the same time the old leaves take a partial yellowish color forming a mosaic of yellow and green spots. The old leaves are partly curled and the leaf blade presents gradations which closely resemble analogous formations in tobacco mosaic. In the course of one or two months all leaves either young or old, fall off after turning entirely yellow or they dry up and the petiole bends but the leaves do not fall. The plant rarely bears during this period and if it does, it is unable to develop the fruit to maturity. When the plant loses its leaves, new growths are developed generally apically, frequently they are lateral growths but they never appear in multiple formation. Sooner or later they assume the diseased appearance previously described and on falling, are replaced by similar new growths. This condition may prevail for a number of months (or even for a year or two) when the plant finally dies; it is very seldom that the plant succumbs to the first attack. In a number of cases, but not invariably, the trunk shows a series of epidermal suberous growths which appear irregularly and lengthwise, generally in the top-most part. These suberizations are formed by stratified layers of cork, slightly sub-epidermal, which are not found on healthy plants and whose presence we were unable to understand. A number of researches on the latex of the papaw tree in different places and at various times gave negative results with the exception of bacterial zoogloeae which was found once. We have never succeeded in discovering

protozoa.* A further series of inoculation experiments using latex of diseased plants gave different results; in one instance most of the plants inoculated were infected (18 out of 20); in other cases the percentage was smaller (3 out of 9 plants; 5 out of 14; 2 out of 17 and 1 out of 18). Possibly this is the same as the disease reported on this plant in Jamaica.

FRUIT FALL (*Thielaviopsis paradoxa* (Seyn.) v. Höhn.). This disease is quite common during the winter and spring, but is of no economic interest. Artificial infections developed the disease on this plant as well as on *Curcubita moschata* and *Anacardium occidentale* (5).

FRUIT ROT (*Rhizoctonia papayae* Cif.). A common disease of destructive character during heavy rains, but not at other times. While it may affect all the fruits on a plant, it generally attacks those growing near the ground. The fungus lives in the soil, preferably in the surface, among rotted leaves, etc. and gradually moves upward to the fruit. It can make its entrance only through a wound, such as those incisions made on the fruit to drain out the latex before the fruit ripens or by any other mechanical injury. The disease has been reproduced artificially only through wounds. Where the fungus makes its entrance a depression is formed which becomes soft and of a dark yellowish tinge. The mycelial hypha rapidly ramifies invading all the mesocarp until it reaches the interior cavity where a white coat is formed over the seeds and checks their growth. The fruit turns yellow as if it were ripening, but it actually rots and softens through the action of this fungus or other micro-organisms. It finally falls to the ground. The fungus does not form sclerotia in culture, but only in the interior of the fruit in the intercellular spaces of the mesocarp. This disease may be checked or its damage reduced by frequent cultivations of the soil and by avoiding the planting of dwarf varieties or varieties which bear low. It has been demonstrated that the fungus lives in the soil. A more complete paper on this subject is in the course of preparation.

LEAF SPOT (*Puccinopsis caricae* (Speg.) Earle). Very common but rarely injurious.

PEA (*Pisum sativum* L.)

Very rarely cultivated.

LEAF SPOT (*Cercospora pisi-sativae* Stev.). Not abundant.

* In Moca, in the latex of the *Asclepias curassavica* a flagellate was once discovered apparently very similar to the *Leptomonas Elmassiani* Mig., and this same species or one of great affinity was once found in the latex of *Calotropis procera*, in a plant in the neighborhood of Bani.

POWDERY MILDEW (*Oidium erysiphoides* Fr.) Of little importance.

PEANUT (*Arachis hypogaea* L.)

This plant is extensively cultivated in Santo Domingo, especially in the regions of Villa Vázquez, Santiago and in the southern part (San Juan de la Maguana). In spite of this, the exports are very limited. This plant is affected by a number of insects and diseases, often associated, and both of which are injurious.

LEAF SPOT (*Cercospora personata* E.). Very frequent, but causing serious damage only occasionally.

ROOT DISEASES (*Rhizoctonia* sp.). The most serious disease which may cause a considerable reduction of the crop during periods of heavy rains, especially in Cibao.

RUSTS (*Uredo arachidis* Lagh.). Very common but as a rule not injurious except in the case of young plants.

PEPPER (*Capsicum annum* L.)

This crop is grown throughout the country, but less abundantly than any other solanaceous crop.

LEAF SPOT (*Cercospora capsici* Heald & Wolf.). Quite common but of little economic interest.

MOSAIC (?) Not very common and consequently unimportant.

ROOT ROT (? *Rhizoctonia* sp.). Rare in the Cibao and of no importance.

SPOTTED FRUIT ROT (*Gloeosporium piperatum* E. & E.). This disease is less widely spread than the zonate fruit rot with which it is at times associated and is of little economic importance.

ZONATE FRUIT ROT (*Colletotrichum nigrum* E. & H.). The most common and injurious disease, which under favorable growing conditions (wet weather) may destroy 75 per cent of the crop.

PINE (*Pinus occidentalis* Sw.)

This tree is widely distributed wherever ways of communication permit it and covers a vast area, especially in the Central Cordillera (see map on page 9). We have not discovered any diseases on pine worth mentioning and, as far as can be ascertained, it is not affected by rusts.

Pineapple (*Ananas Ananas* (L.) Cock.)

This plant grows throughout the Republic but is most intensively cultivated along the Cibao district, chiefly in La Vega, where exquisite fruit of a very sweet and fragrant variety, locally known as "pan de azúcar" (sugar-loaf pineapple) is produced. However, its cultivation has not been industrialized although there is a tendency towards a greater development. Cryptogamous diseases cause appreciable damage to the crop.

Fruit bacterial brown-rot (*Erwinia ananassae* Serr.) This disease the cause of which we have not been able to isolate, but which appears to be identical with the disease reported from the Philippines and Haití, is quite familiar although it varies considerably. The pineapple denominated "francesa" (Smooth Cayenne ?) is apparently affected by diseases as severely as the native sugar-loaf pineaple. The disease is most common in the Cibao region.

Base rot (*Thielaviopsis paradoxa* (De Seyn.) *v.* Höhn.). This disease is spread all over the country but is especially serious in the districts of Espaillat, Duarte, La Vega and Samaná where during the rainy season the crop is considerably reduced.

Brown leaves, Chlorosis, Tangle foot, etc. (Different causes). We have grouped together a number of diseases, the causes thereof being difficult to identify. They are largely due to parasitic agents, or at least primarily so, evèn though organisms of secondary importance may follow. These diseases may be due to manifold causes; lack or excess of water, comparatively high lime content of soil, excessive clayey soil, inadequate preparation of soil, lack of the necessary assimilative nutritive elements in soil, etc. This group of diseases is often found in pineapple plantations and prevents a profitable cultivation of the fruit in certain localities.

Root diseases (?) This disease is frequent and quite harmful in the clay soils of Cibao during the rainy seasons. It is frequently associated with the base rot.

Potato (*Solanum tuberosum* L.)

The cultivation of this solanaceous crop has been considerably intensified during the last few years, chiefly in the northern and southern districts under irrigation. The output in these districts supply the local market with a good portion for domestic consumption.

DRY ROT (*Fusarium solani* (Mart.) Sacc.). This is the most widely spread disease of the potato, however, it is not very serious.

LATE BLIGHT (*Phytophthora infestans* (Mont.) de Bary). Probably the most serious disease of the potato, especially in the Cibao district and in the South. The mean annual loss may be estimated at not less than 15 per cent; in some cases it may reach 80 per cent. It is less frequent in the tubers.

LEAF SPOT (*Septoria lycopersici* Speg.). Of little economic importance although wide-spread.

SCAB (*Actinomyces scabies* (Thaxt.) Guss.) A common and harmful disease which, however, is confined to certain places in the district under irrigation in Villa Vázquez and in the north where it may cause an appreciable reduction of the crop.

TIP BURN (physiological causes). Quite common, chiefly in the irrigated districts of the north and south, but it is of no special economic interest.

WET ROT. (?) It occurs frequently in stock kept in warehouses and affects both the quantity and the quality of the crop. It is caused by one or more species of bacteria not identified.

SESAME (*Sesamum orientale* L.)

Rarely cultivated in the interior of the country.

BLACK SHANK (*Phytophthora* sp.). This disease assumed a destructive character in Villa Vázquez, in irrigated places and in Santiago, only during 1928. Apparently it presents the same characteristics as a similar disease on tobacco. In the course of a few days, usually a week, the plant dies, the leaves dry, the stem becomes black and the disease, even post-morten, spreads from the lower portion of the stem, upward. In infected material in a damp chamber we have observed the rapid growth of a Phytophthora, not found in all the specimens. This fungus has been held responsible for the disease. The fungus is frequently associated with a *Fusarium* sp., as in the case of tobacco, which has a disease very similar to this one. Wherever the fungus developed in 1928 it totally exterminated the sesame plots, but we have not discovered this disease in other parts of the country.

LEAF SPOT (*Cercospora sesami* Zimm.). Very common everywhere, but of no economic importance.

ROOT ROT (*Rhizoctonia* sp.). Occurs rarely in the clay soils in Cibao during rainy seasons.

Squash (*Pepo* sp.)

Widely cultivated but only for local consumption.

Downy Mildew (*Pseudoperonospora cubensis* B. & C.). It is a common but unimportant disease.

Pineapple disease (*Thielaviopsis paradoxa* (De Seyn.) v. Höhn.). This disease did not appear spontaneously but was artificially caused by inoculating this fungus into the young fruit with cultures of fungus isolated from papaw (5).

Star apple (*Chrysophyllum Caimito* L.)

Common but rarely cultivated.

Root rot (?). Of the very few parasites of this tree, this is the only one of any interest.

Sugar cane (*Saccharum officinarum* L.)

This plant, extensively cultivated throughout the southeastern part of the Republic, and to a more limited extent in the southwest and north, is the most important crop of the Island. The phytosanitary conditions, have been improved in recent years but are not good and the yield of sugar is generally low.

Leaf spots (*Helminthosporium ocellum* Faris; *H. stenospilum* Drechsler; *Cercospora sacchari* v. Breda de Haan). While these three fungi are widely distributed they can not be regarded as causing appreciable damage in cane varieties that are extensively cultivated.

Leaf variegation (?). Apparently this disease is not of an infectious nature. We have found it only on Cristalina and Japanese canes and so far as can be ascertained it does not cause serious losses.

Mosaic (?). This is undoubtedly the most serious sugar cane disease, all others being comparatively unimportant. Plantations were originally planted to "Caña-blanca" or "Cristalina" and allowed to run for ten or even twenty years; the cane being cut every year. With the spread of the mosaic, care was not taken to plant seed of healthy cane, or to eliminate the diseased young plants or to substitute rapidly the old varieties by resistant or immune varieties. Consequently a general low yield followed and this depression was aggravated by low sugar prices since 1925. After a number of experiments, some of which were unsuccessful, the old canes

have been substituted by new varieties, particularly during 1927 and 1928. At the present time the POJ–varieties, especially POJ–2725, are the most popular. The POJ–2878, recently introduced, is being extensively propagated and the POJ–2883 will shortly follow. However, the substitution in plantations where there is a high percentage of disease is not proceeding as rapidly as is desired, chiefly due to the economic crisis of the sugar industry. There are still a large number of fields which should be replanted with new varieties. Fields with 100 per cent infection are of very common occurrence.

PINEAPPLE DISEASE (*Thielaviopsis paradoxa* (De Seyn.) v. Höhn.). An uncommon disease which we have observed only twice. It is of no economic importance.

POKKAH-BOENG (*Fusarium* sp.). This disease, so far, has been discovered only on POJ–2714, POJ–2725, and POJ–2878, but does not cause serious damage. The last mentioned variety appears to suffer most. It is possible that the slight damage is due to the comparatively limited propagation of this variety. The cases reported on Cristalina should be referred, in our opinion, to the twisted-top and not to the "pokkah-boeng."

RED ROT (*Colletotrichum falcatum* Went). In relation to the damage caused, this disease is second only to mosaic. It is difficult to give any definite figures regarding the extent of the damage which varies greatly from year to year. This fungus may also present a form of Hyphales Tuberculariaceae (5).

RED ROT OF LEAF SHEATH (*Sclerotium Rolfsii* Sacc.). Wide-spread but of no economic importance.

RED SPOT OF LEAF SHEATH (*Cercospora vaginae* Krüger). About the same as the preceding.

RIND DISEASE (? *Pleocyta sacchari* (Mass.) Petr. & Syd.). This disease, whose existence as a separate entity is doubtful, does not cause appreciable damage.

ROOT DISEASES (*Rhizoctonia* sp. with other fungi, not determined). They are less serious than the preceding, but very common. A careful investigation on the percentage and general damage did not give positive results. A study made by the author showed this disease to be related to the mycorrhizic infection and the pathogenic agents are some species of Rhizoctonia and a Phycomycete, not identified, probably different from a *Pyythium* sp. common on diseased roots (7).

We might mention that so far we have not been able to find the "gum disease", or the "dry top rot" in Santo Domingo.

Sweet potato (*Ipomoea batatas* (L). Lam.)

A large number of varieties are extensively cultivated in Santo Domingo, the total production being used for local consumption. The damage done by diseases is limited and the plant suffers more from the attack of the *Cylas formicarius* Fabr. and various other insects.

Black rot (*Sphaeronema fimbriatum* (E. & H.) Sacc.). The most common and injurious disease affecting sweet potato.

Java black rot (*Diplodia* (*Lasiodiplodia*) *tubericola* E. & E.). Common and quite severe, varying according to the season and place.

Leaf spot (*Cercospora bataticola* Cif. & Brun. ad. int.). Rare and of no economic importance. This species is quite different from *C. batatas* Zimm.

Rust (*Coleosporium ipomoeae* (Schw.) Burr.). Very common but of no interest from the economic point of view.

Soft rot (?). A common disease which may affect sweet potatoes both stored and under the ground. It may be the most important disease in plantations poorly cultivated and is probably due to several different causes.

Sclerotial blight (*Sclerotium Rolfsii* Sacc. and ? *Rhizoctonia* sp.). Uncommon and harmless.

Molds or soft rot (*Rhizopus* sp. and allies). A very common disease which occurs on stored potatoes and is more or less serious.

White rust (*Albugo minor* (Speg.) Cif.) Very common but without any economic importance. The author (6) found a biological specialization of the *Albugo* on this plant in connection with the same fungus living upon other Convolvulaceae on the basis of cross inoculations and biometric criteria, thus accepting the Spegazzinian name and elevating the variety of this author to the rank of a species.

Tobacco (*Nicotiana tabacum* L.)

Among the crops of secondary importance, this is one of the first. The value of tobacco exports, however, is subject to considerable fluctuations. It is mostly cultivated in Santiago and in other provinces of the Cibao Valley, but to some extent, throughout the Republic. The adult plants suffer severely from the attacks of insects, chiefly the *Protoparce sexta.* The most popular variety is the one denominated "Criollo" a hardy and resistant veriety but of poor quality, especially the low, unselected grade. The cultivation

of the "Habana" variety and of other varieties of good quality such as a hybrid of "Sumatra", etc. is quite limited.

BLACK SHANK (*Phytophthora nicotianae* van Breda de Haan). A very rare disease which normally is of no economic importance probably due to the comparatively high resistance of the "Criollo" variety generally cultivated. On the contrary we have observed it to assume a destructive character on foreign varieties of recent importation and cultivated for experimental purposes, such as a series of varieties of the oriental type, a "Virginia" variety and one known as "Egipcia".

DAMPING-OFF (*Pythium de Baryanum* Hesse and *Rhizoctonia* sp.). This is the principal and most harmful tobacco disease even though the loss in seed beds is not great. The practice of making seedbeds without previously sterilizing the soil or in inadequate plots, and during rainy seasons, favors the development of this disease. The principal agent appears to be *Pythium de Baryanum*, even though at times it is partly due to one or more species of Rhizoctonia. The writer made a number of experiments for the purpose of developing an economical and efficient prophylactic treatment, and after numerous tests, it is recommended to use the mercury-organic compounds.

LEAF SPOTS (*Cercospora nicotianae* E. & E.). Very common but of no economic importance. The same may be said of the *Phyllosticta hainensis* Frag. & Cif., an endemic species which is confined to the southern coast and the *Sphaerulina hainensis* Frag. & Cif., which is probably a semiparasite and occurs in the spots of the *Cercospora nicotianae*, also restricted to the same region and very uncommon.

MOSAIC (?). Scattered widely and irregularly in tobacco fields. The most serious forms are less frequent. The disease appears to be quite injurious in spite of which it is overlooked by growers.

ROOT DISEASE (*Rhizoctonia* sp.). Not frequent and apparently confined to the tobacco fields in humic clay soils, especially in the northeastern part of the Cibao Valley. Does not cause great injury.

WILT (*Erwinia solanaceara* (E. F. S.) Comm.). A very exceptional disease; even the very few cases reported appear doubtful in that the microorganism which produces the bacteriosis was not studied in pure culture and the disease was only identified by its etiological characters. If the disease actually exists, there is no doubt that the "criollo" tobacco is highly resistant to it.

Tomato (*Lycopersicum lycopersicum* (L.) Karst.)

This plants grows throughout the country but its cultivation is quite limited.

Anthracnose (? *Phoma destructiva* Plowr.). One of the most familiar tomato diseases which may reduce the crop in certain plots to about 50 per cent. The parasitic agent was not definitely identified and appears sporadically.

Bacteriose (*Erwinia carotovora* (Jones) Holl.). This disease which affects the young fruit does not arise naturally and was only artificially produced by inoculations.

Cracks (?) Apparently they are not of parasitic origin and they are of no economic importance.

Damping-off (? *Pythium* sp.). Very frequent in seed beds and while the percentage of dead plants is high, it is of no great importance.

Mosaic (?) Very common; however it is rather harmless.

Nailhead rust (*Alternaria solani* (E. & M.) J. &. S.). Very common but not important.

Fusarium wilt (*Fusarium lycopersici* Sacc.). Less frequent and serious than the preceding; it is found principally in the regions under irrigation in the northwest and southwest.

Late blight (*Phytophthora infestans* (Mont.) De Bary). Very common at certain times of the year. It is undoubtedly the most injurious of the tomato diseases and may destroy all the plants in a plot.

Leaf mould (*Cladosporium fulvum* Cke.). This fungus usually attacks the leaves and is rarely injurious, except when it affects the fruit.

Leaf spot (*Septoria lycopersici* Speg.). Usually of no economic interest.

Root rot (*Rhizoctonia* sp.). Apparently uncommon and confined to the Cibao district; it is of little importance.

In addition to the above, mention should be made of a tomato rot disease in which we have repeatedly discovered the *Cephalosporium acremonium* Corda. Inoculation experiments made on healthy fruit, ripe or green, by spraying a suspension of conidia, gave negative results. It has been observed that during rainy weather a very small wound is sufficient for the fungus to invade the ripe fruit rapidly and cause it to rot. This disease shows a great similarity to the *Oospora* rot reported as serious in Florida.

Tonka bean (*Coumarouna punctata* Blake).

This plant has recently been introduced from Venezuela. The success obtained from the first planting has resulted in the extension of plantings which are increasing rapidly, consistent with the good characteristics of the tonka as a crop plant.

Leaf spot (*Phyllosticta diptericicola* Frag. & Cif. and other fungi). The *Phyllosticta diptericicola* is usually associated with the root disease, of which it is generally an exterior symptom; however, it may also affect leaves of plants whose root systems are healthy. Associated or separately the following fungi may be found; *Melanochlamys coumarounae* Frag. & Cif.; *Didymosphaeria coumarounae* Frag. & Cif.; *Leptosphaeria coumarounae* Frag. & Cif., etc., which are in all probability of secondary importance.

Root disease (?). The most wide-spread and harmful disease. The causes are unknown to us. The young plants up to the third year are more susceptible to the disease than the adults. The percentage of dead plants may be estimated at not less than 50.

Yam (*Dioscorea* spp.)

Rarely cultivated although growing throughout the country.

Leaf spot (*Cercospora carbonacea* Mill.) Discovered several times in Moca as the cause of some damage. Although a few species and varieties of *Dioscorea* were growing together *D. alata* L. was the only one affected by the disease.

Zapote (*Calocarpum mammosum* (L.) Pierre)

Rarely propagated and of local interest.

Fruit rot (?) Due to an undetermined cause, but possibly, or at least in some cases, it is due to *Colletotrichum gloeosporioides* Penz., which we have discovered on more than one occasion. The disease is frequent and causes a large percentage of fruit loss.

Summary

This comprises a list of the most important diseases from the economic point of view, which affect cultivated plants in Santo Domingo, with brief notes on their importance and distribution, as well as the most widely distributed diseases of little economic importance and also those of marked scientific interest. In a very general way, mention is also made of a number of experiments that were made,

some of which have been reported and others are in the course of publication. We also touch briefly on different diseases which are new or almost unknown.

Following a short introduction aiming to enumerate the previous phytopathological and mycological surveys and a brief statement regarding the agricultural production of Santo Domingo and the different agricultural zones of the Republic, we discuss 53 cultivated plants, affected by 175 diseases of which 122 are presumably or definitely ascribed to fungi, 33 to non-parasitic causes, virus or unknown causes, 13 to Schizomycetes, 3 to Algae, and 3 to parasitic Phanerogams. The total number of fungi reported totals 151, in addition to which 13 insects are cited among those of greater interest.

A more complete study is made of the principal plants of the Republic from the economic standpoint namely sugar cane, cacao and coffee.

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EXPLANATION OF PLATES

PLATE NO. I

Fig. 1.—Twig and leaves of a cacao plant affected by "roncet", showing the alterations on the lamina and the foliar limbus.

Fig. 2.—Same as above, but the alterations prevail in the foliar limbus.

Fig. 3.—Appearance of two papaw plants affected by the "curly top"; (figures at the center and to the right); the figure to the left shows a healthy plant. Note the fallen leaves and the new growths,—apical and basal.

Fig. 4.—Twig of cacao affected by the "roncet", resembling the "witch's broom". Note the exceptionally long stems with small leaves, poorly shaped.

PLATE NO. II

Fig. 5.—The upper figure shows a papaw plant affected by the "curly top". Note the lateral leaves partly fallen and the formation of the rosette of leaves.

Fig. 6.—Young rosette with small leaves densely clustered; the stem is all covered with corky layers.

Fig. 7.—Part of a stem showing layers of cork.

Fig. 8.—Leaves intensely curled but showing little or no discolorations of mosaic nature.

Fig. 9.—An old leaf, curled and with discoloration of mosaic character.

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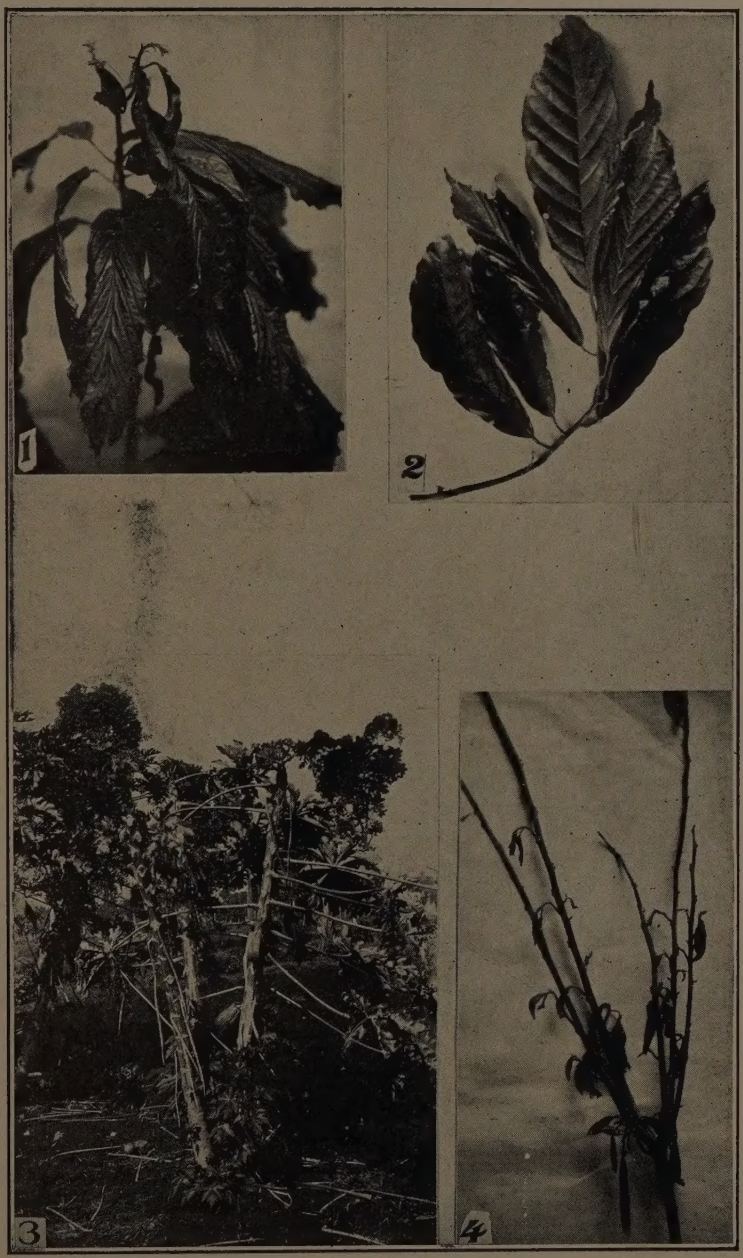
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PLATE II